# Interim Report on CHEMICAL CONTROL OF RIGHT-OF-WAY BRUSH on Rural Power Systems

U. S. DEPARTMENT OF AGRICULTURE

RURAL ELECTRIFICATION ADMINISTRATION

# CHEMICAL CONTROL OF RIGHT-OF-WAY BRUSH ON RURAL POWER SYSTEMS

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# CHEMICAL CONTROL OF RIGHT-OF-WAY BRUSH ON RURAL POWER SYSTEMS

## I. INTRODUCTION

### A. GENERAL

The control of woody growth presents a serious right-of-way maintenance problem for rural power systems. REA-financed electric cooperatives alone operate enough miles of transmission and distribution lines to circle the globe 30 times. A large part of this mileage is in areas where growth control constitutes a problem.

Right-of-way clearing is necessary to make lines accessible for patrol and repair, lessen the outages by keeping brush from making contact with conductors, and to maintain an attractive appearance. Many rural electric cooperatives are now facing this problem without extensive experience in dealing with it. This is because initial clearing for a new line eliminates most brush for several years, and reclearing only recently has become necessary.

In some areas labor costs have reached a point where hand brush clearing methods are not economical or are unsatisfactory. In recent years, therefore, rural electric cooperatives and commercial utilities have started to use herbicides (chemical weed killers) for brush control. Much of this work has been experimental, but in some cases the use of chemical sprays has become a major part of the brush control program.

### B. SCOPE

This report is provided to make information on chemical brush control available for those concerned with it. The information herein was obtained from rural power systems, chemical manufacturers, tree expert companies, State and Federal agencies and others. (See Appendix I, page 18 ). Results of field tests conducted in 1948 by rural electric cooperatives and coordinated by the Rural Electrification Administration are reported. This report discusses herbicides and application methods used by the above groups, as well as results obtained and costs of treatment.

Much information is still needed to indicate the ultimate capabilities of herbicides, the best chemicals for a particular use and the most effective methods of application. There obviously remains a need for extensive basic research and experimentation over a long period of years.

## II. HERBICIDES FOR WOODY PLANTS

### A. GROWTH REGULATING HERBICIDES (2,4-D; 2,4,5-T AND OTHERS)

Growth regulating compounds affect the growth processes within plants. Some of them have killing effect when applied to certain plants. The growth regulating types of herbicides differ from "contact" herbicides in that their effect is to accelerate or over-stimulate certain physiological processes in the plant to the point where the plant is killed. "Contact" herbicides break down the protoplasm or disorganize the contents of many of the living cells, causing the death of the plant in this way. The growth regulating herbicides translocate in the plant, thus killing the roots as well as the tops to which they are applied.

The best known and most widely used growth regulator is 2,4-D (2,4-dichlorophenoxyacetic acid), which has been used as a herbicide during the last five years. It is least expensive of the herbicides for woody plants, is not corrosive to metals and, as normally used, is not hazardous to humans nor animals.

Another growth regulator more recently developed commercially as a herbicide, is 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), which is more expensive than 2,4-D and will control some of the plants not well controlled by 2,4-D. Due to their selective action, the growth regulators do not kill all species of woody plants.

The ester formulations are at present the most widely used for control of woody plants. The salts of the acid, mixed with oil, are also being used. The salts are less volatile than the esters.

Table IV on page 14 lists woody plants according to their reactions to 2,4-D and covers two year's experience. Table V on page 15 and Table VI on page 16 list, respectively, woody plant reactions to 2,4,5-T and to a combination of 2,4-D and 2,4,5-T, and cover one year's experience. It is evident that research with the growth regulator herbicides is too recent for definite recommendations for their use for over-all control of brush.

### B. AMMONIUM SULFAMATE

Ammonium sulfamate "Ammate" has been known as a herbicide since 1936. Like the growth regulating compounds, it is also translocated in the plant. "Ammate" is being used extensively for brush spraying by at least one large tree expert company doing contract work for a number of utility companies and electric cooperatives. It is also being tested by Federal and State investigators for use in killing brush.

### C. SODIUM CHLORIDE

Sodium chloride (common salt) has been used extensively in eradication of the common barberry.

### D. CHLORATE COMPOUNDS

Some of the chlorates are highly inflammable. Hence they cannot be used as a spray on foliage, wood, cloth, or other organic substances. Sodium chlorate is in this class. It is used in applications to the soil to kill deep-rooted perennial weeds and troublesome grasses. "Atlacide," a product of the Chipman Chemical Company is used as a herbicide. It contains calcium chlorate and sodium chlorate, but its flammability has been reduced. It is applied either as a spray or in dry form.

### E. BORON COMPOUNDS

The Pacific Coast Borax Company processes and sells a variety of boron compounds. One of the best known of these is "Borascu," which is applied to the soil in sufficient quantities to make it toxic to plants.

### F. ARSENIC COMPOUNDS

Most arsenic compounds consist of a strong solution of sodium arsenite, sold under numerous commercial brands and used widely for miscellaneous weed control. They are toxic to all kinds of plants when applied as a foliage spray or when stirred into the soil around the roots. Sodium arsenite is very poisonous. It presents a hazard to grazing animals and to the persons using it and for that reason must be used with great caution.

### G. PETROLEUM PRODUCTS

Oil of any kind is likely to be injurious to plants, but some oils, chiefly in the aromatic group, are also toxic. These oils are likely to be in the cheapest oil derivatives, such as fuel oil, diesel oil, stove oil and similar products.

Some of the oils in combination with growth regulating herbicides have proved effective in foliage and stump sprays, applied to woody plants. In this use the oils function chiefly as carriers and to improve the penetration.

### H. OTHER HERBICIDES

Pentachlorophenol, a wood preservative, is also used in various forms as a herbicide. "Penta General Weed Killer Concentrate," manufactured by the Chapman Chemical Company, is a mixture of chlorinated phenols with aromatic petroleum oils and a small amount of 2,4-D. Anumber of herbicides are used in the control ot undesirable grasses in substations and pole yards. Among these are oils, pentachlorophenol, dinitrophenol and O-isopropyl N-phenyl carbamate. One of the newer herbicides developed recently that shows considerable promise as a grass killer is trichloroacetic acid. This is marketed in sodium and ammonium trichloroacetates. Another new herbicide is polybor chlorate which is being used in pole and substation yards.

## III. METHODS OF APPLICATION AND RESULTS

### A. FOLIAGE SPRAYING

Most of the chemicals discussed in this report were applied during the growing season as foliage sprays. A description of the spraying equipment used is given in Table II on page 12 . In addition to the power sprayers listed in the table, knapsack sprayers were used by several of the groups. They were used for spraying in areas where automotive equipment could not be driven or where touch-up work was to be done. Knapsack spraying involved the application of low volume of a solution more highly concentrated than that applied by power sprayers.

The chemical most extensively used in 1948 was 2,4-D. The total area sprayed by electric cooperatives with 2,4,5-T alone and with "Ammate" was relatively small. Table I, beginning on page 10 , containing data from REA-financed power systems and private utility companies, indicates the strength of solutions used, amount applied per acre and the results observed for most of the foliage spraying done. It also includes data for small experimental plots. The notation, "Not conclusive," in the "Results" column of the table indicates that, at the time the observation was made, spraying had been so recently done that a conclusive estimate of the control obtained could not be made.

A few reports were received describing unsatisfactory results where 2,4-D was used in an oil as a foliage spray causing defoliation before the 2,4-D was absorbed by the plants.

B. STUMP SPRAYING

Two electric cooperatives reported the use of mixtures of 2,4-D ester (40%) and kerosene. The South Crawford Rural Electric Cooperative, Denison, Iowa, used one part of 2,4-D to 99 parts of kerosene on the stumps of box elder, plum, ash, cottonwood, walnut, elm and maple. The Magnolia Electric Power Association, McComb, Mississippi, used one part of 2,4-D to 25 parts of kerosene on the stumps of willow, sweet gum, poplar, alder, prince mulberry and sumac. In both tests there was considerable resprouting later in the season.

The Magnolia Electric Power Association also used a stump spray mixture of 5 pints of 2,4-D to 100 gallons of water. This was not effective.

The South Crawford Rural Electric Cooperative placed saltpeter crystals in holes bored in cottonwood stumps. The resprouted growth was yellowish and stunted. An arsenic mixture, used on several trees, was not effective.

The Winnebago Rural Electric Cooperative Association, Thompson, Iowa, placed 2,4-D powder in holes bored in live stumps and tree bases. Both stumps and trees were killed. A solution of one quart of the amine form of 2,4-D to 100 gal. of water, sprayed on stumps, was not effective.

The 1948 research report of the North Central Weed Control Conference indicates that application of concentrated herbicides to freshly cut surfaces is estimated to reduce the amount of regrowth by more than sixty percent. "Ammate" applied in this manner was effective, but similar tests with 2,4-D yielded inconclusive results.

C. TREATMENTS IN SUBSTATION AND POLE YARDS AND AROUND WOOD POLES

The Winnebago Rural Electric Cooperative Association experimented with borax and "Ammate," applied to the soil where the principal growth was quack grass. borax, applied at the rate of 12-1/2 or 20 lb. to 100 sq. ft., did not seriously injure the plants. "Ammate," applied at the same rate, killed the tops.

The Craig-Botetourt Electric Cooperative, New Castle, Virginia, made an application of borax to the soil in pole and substation yards at the rate of 10 to 15 lb. to 100 sq. ft. The growth included grass, weeds, honeysuckle, persimmon and briars. Good results have been reported from this test. The cost of borax is approximately $85 per ton in small lots, $80 per ton in large lots. "Ammate" costs from 11 to 14 cents per pound.

Weed Control Service, Inc., Portland, Oregon, reported excellent results from the application of "Atlacide" and polybor-chlorate around wooden pole structures belonging to the Pacific Coast Power and Light Company, Portland, Oregon, at a cost of 55 cents per pole. Either chemical was applied over a 5-ft. radius, at the rate of 1-1/2 lb. to 30 sq ft. In areas having less than 12 inches of rainfall per year an application was made the first two consecutive years of the treatment, then every other year. In areas with more rainfall it was found necessary to apply the chemical every year.

Weed control in substations, pole yards and around wooden pole structures is often desirable for the purpose of fire prevention, as well as to improve appearances.

D. RESULTS REPORTED BY THE NORTH CENTRAL WEED CONTROL CONFERENCE FOR 1948

Tables IV, V, VI and VII, pages 14 to 17, summarize tests on woody plants on which reports were received in 1948 by the North Central Weed Control Conference, relative to plant reactions to 2,4-D; 2,4,5-T and a combination of 50 percent each of 2,4-D and 2,4,5-T.

Most of the data were obtained in the North Central states. The complete tabulation of data included the following:

Common and scientific names of woody plants sprayed.
Form and concentration of chemicals used.
Type of treatment, to foliage, to cut surfaces or on dormant plants.
Type of reaction according to stage of growth.

Type of reactions was classified as follows:

Type I (hypersensitive) Any plant that is killed in certain designated stages of growth by one application of a given chemical.

Type II (sensitive) Any plant that in certain designated stages of growth reacts to a given chemical and may be killed by repeated applications.

Type III (semi-tolerant) Any plant that in certain designated stages of growth reacts to a given cnemical, but is not killed by repeated applications.

Type IV (tolerant) Any plant that in designated stages of growth shows negligible reaction to a given chemical.

Stage of growth was classified as follows:

Young seedling.
Early season, succulent growth.
Midseason, succulent growth.
Midseason, no succulent growth.
Late season or pre-dormancy.
Dormancy.

The results summarized in Tables IV and V were obtained from tests made by numerous experimenters. In many cases, they did not include a test for each of the stages of growth. The chemicals were generally the ester form, in various strengths of solution with water, sprayed on the foliage. A few tests utilized the growth regulator in solution with Diesel oil. Some applications were made to brush during the dormant season, as well as to cut surfaces at various stages of growth. The results summarized in table VI were obtained by F. A. Ashbaugh, West Penn Power Company, Pittsburgh, Pennsylvania. He made tests with 50 species during all stages of growth except dormancy.

The above mentioned tables do not make a distinction between type III and type IV reactions as did the data submitted by the experimenters, since plants in either category were not killed by the growth regulator used. The tables indicate erratic results for many plants. Table IV covers two year's results with 2,4-D and tables V and VI cover one year's results with 2,4,5-T and the combination of 2,4-D and 2,4,5-T. The success or failure of the chemical to kill depended upon the kind of solution used, the locality where test was made, the stage of growth, type of treatment, application technique, resistance of the plant or other factors.

Table VII is a tabulation of percentages of tests, showing plants in the type I or II reaction groups at various stages of growth. It is noted that 2,4, 5-T generally produced better results than 2,4-D and that a combination of 2,4-D and 2,4,5-T was superior to either chemical used singly.

Summarizing the reactions in all tests of plants with regard to percentage of total tested by a given chemical at any stage of growth, the type I reactions were as follows:

1. 2,4-D . . . . . 24%
2. 2,4,5-T . . . . . 32%
3. 2,4-D and 2,4,5-T combination . . . . .37%

Similarly the type II reactions were as follows:

1. 2,4-D . . . . . 33%
2. 2,4,5-T . . . . . 36%
3. 2,4-D and 2,4,5-T combination . . . . .37%

Some experiments were reported to the 1948 North Central Weed Control Conference where comparisons had been made between 2,4-D; 2,4, 5-T and "Ammate." The results are summarized as follows:

1. Osage orange, 6 to 15 feet tall in the small seed-ball stage of growth was sprayed with ethyl esters of 2,4-D, 2,4,5-T; the amine salt of 2,4-D and "Ammate."

   Results were inconclusive, but 2,4,5-T appeared to be the most promising of the three herbicides.

2. Plots of various species of woody plants in Minnesota were sprayed with 2,4-D (83.5% salt) at 2-1/2, 5 and 7 1/2 pounds per acre and "Ammate" at 50, 125 and 200 lbs. per acre. "Ammate" appeared to be less selective, particularly at higher concentrations. For the two lower concentrations of the two chemicals, less resprouting occurred where 2,4-D had been applied, but the least where the highest concentration of "Ammate" had been applied.

3. Tests were made in Minnesota to determine the minimum amounts of six different chemicals including 2,4-D; 2,4,5-T; and "Ammate" to kill 100 shoots of hazel brush. Only four of the six chemicals gave satisfactory results.

   They are arranged in order of increasing cost as follows:

   2,4-D (83.5% salt) . . . . . 0.5 oz
   Esteron 44 (44% ester). . . . . 0.1 pt
   2,4,5-T (43%) . . . . . 0.1 pt
   "Ammate" . . . . . 1.0 lb

   Each quantity shown was applied in two gallons of water.

4. Tests on alder brush using (a) 2,4,5-T "Esteron 245" at strength of 1 to 200 of water as a spray and (b) "Ammate" applied to freshly cut stumps with 21.3 pounds of "Ammate" per acre (2 pounds per gallon of water), indicated 93% reduction of stems for plots treated with the 2,4,5-T at cost for chemicals of $10.95 per acre and 87% reduction of stems for plots treated with Ammate at a cost of $24.81 per acre.

5. Second year results of different methods of applying to alders four different chemicals including 2,4-D and "Ammate" were reported. The tests had been made near Hiles, Wisconsin. The least expensive method which produced effective results was that of cutting old brush in May and spraying the resprouted growth with 2,4-D ester solution in August. The second least expensive method, also producing effective results, was the use of a 2,4-D ester foliage spray.

   It was concluded from the comparison of growth regulators with "Ammate" that the latter still has a place as a herbicide in spite of its limitations.

# IV. COST CONSIDERATIONS

## A. CHEMICALS

The unit costs of the herbicides used depend to some extent upon the amount purchased. In the case of the growth regulators, costs also depend upon the percentage of acid present. Prices of the total quantity of each chemical, sufficient for spraying 50 acres of brush, delivered to the Bell Telephone Laboratories, Murray Hill, New Jersey, may be considered as an example. The prices were computed, based on the amount of each chemical used in test plot treatments and quotations furnished by the various suppliers. The following list with chemicals arranged in order of increasing cost, gives the cost per acre for chemicals only, applied under test conditions:

1. 2,4-D (Esteron 44) . . . . . $ 7.00
2. 2,4,5-T (Esteron 245) . . . . . 13.00
3. Pentachlorophenol . . . . . 31.00
4. "Atlacide" (chlorate salts, dry). . . 63.00
5. "Ammate" (ammonium sulfamate) . 66.00
6. "Atlacide" (liquid) . . . . . 72.00
7. "Chlorax" (chlorates and boron salts) . . . . . 87.00
8. "Chlorax" (dry) . . . . . 99.00

## B. BRUSH SPRAYING

The cost per acre of area sprayed varied widely, depending on a number of factors. The amount of chemical used depended on the height and density of brush and the strength of the mixture applied. The labor costs depended on the rate of application, accessibility to the site, the wage rates, the time spent in obtaining water and the time required to go to and from the areas to be sprayed.

The cost figures given in Table III on page 13 , are shown as the cost of labor and chemicals only where these costs are itemized. Stump and yard treatment costs are not given, since this type of chemical use was on a small scale. The costs of spraying experimental plots of brush are not shown for most tests, since the cost of such work was not considered representative of more extensive operations.

## C. COMPARATIVE COSTS OF SPRAYING AND CUTTING

The cost of cutting was reported to be from one to five times as high as the cost of spraying, where sufficient use of both methods supplied information to make a comparison of the costs. The South Crawford Rural Electric Cooperative estimated the cost of manual cutting at $200 per acre. The Winnebago Rural Electric Cooperative Association estimated the cost of hand cutting to be about 5 times that of spraying. In this case, the cost of piling and burning was included in the cost of cutting. The Central Electric Cooperative, Inc., Parker's Landing, Pennsylvania, was also engaged in clearing brush by manual labor and by the use of tractor-mounting power saws. This cost from $30 to $60 per mile of right-of-way about one third covered with brush. The cost amounted to approximately $35 to $65 per acre cleared. The West Penn Power Company expects the cost of five sprayings in ten years to be one half that of equivalent brush control by cutting.

# V. PRECAUTIONARY MEASURES

Several cases of damage to ornamental plants and field crops were reported due to spraying with the growth regulating compounds. Usually the damage was caused by wind drift of the finer particles of the mixture from sprayer to the damaged area. Volatilization had caused damage in one or two cases, the fumes from the chemical on the plants having been carried by air currents to surrounding useful plants. The ester form of 2,4-D, which is most used to kill woody plants, is much more volatile than the salts and amines of this chemical. Therefore the esters are likely to cause damage by volatilization to sensitive plants in the vicinity of the areas sprayed with them. Domestic plants or crops subject to damage from 2,4-D and 2,4,5-T include the following:

| | |
|---|---|
| Cotton | Legumes |
| Tobacco | Grape |
| Tomato | Fruit trees |
| Potato | Roses and other flowers |
| Most vegetables | Many ornamental shrubs and shade trees |

In at least one state the handling and use of herbicides is regulated by statute. Louisiana passed a law in 1948 which states, "The use of 2,4-D or any herbicide which is injurious to plant life is prohibited except after a written permit for the particular use thereof shall have been issued by the Commissioner (of Agriculture and Immigration.)"

California, Arkansas and Texas have bills pending which would control the handling and use of herbicides in those states. It is probable that other states will consider similar legislation. It is suggested that those contemplating the use of 2,4-D or other herbicides keep themselves advised as to current legislative developments.

Precautionary measures suggested for groups spraying growth regulators on right-of-way brush during the growing season are as follows:

1. Do not spray brush immediately adjacent to valuable plants and crops which may be subject to damage.

2. Do not store growth regulating herbicides near fertilizers, seeds, insecticides, or fungicides.

3. Take into consideration at all times the direction and velocity of wind with regard to the section being sprayed and the adjacent crops.

4. Make certain that the liability insurance carried will provide protection against possible damage by spraying.

5. As a public relations policy publicize the advantages of electric power lines free of brush as compared with the disadvantages of a few cases of damage to plants off the right-of-way.

# VI. SOME FUTURE PLANS FOR USE OF CHEMICALS

The Sugar Valley Electric Cooperative Association, Mound City, Kansas, plans to experiment with foliage sprays of 2,4-D; 2,4,5-T; "Atlacide" and "Ammate." The Magnolia Electric Power Association plans to experiment with foliage sprays of 2,4-D and 2,4,5-T and with stump sprays.

The Craig-Botetourt Electric Cooperative plans to continue tests with "Borascu." The Hancock-Wood Electric Cooperative, North Baltimore, Ohio, will use "Ammate" spray on 20 miles of right-of-way. The Platte-Clay Electric Cooperative, Inc., Platte City, Missouri, plans to continue tests with 2,4-D; 2,4,5-T and "Ammate."

The Whitley County Rural Electric Membership Corporation, Columbia City, Indiana, the South Crawford Rural Electric Cooperative, the Winnebago Rural Electric Cooperative Association, the Central Electric Cooperative, Inc., and the Northern Neck Electric Cooperative, Warsaw, Virginia, plan to continue spraying brush on a large scale. The Central Electric Cooperative, Inc., expects to buy an orchard sprayer, a Dodge Power Wagon and possibly a tank trailer, so that additional water can be carried.

The West Penn Power Company plans to spray all brush on its transmission line right-of-way twice during the first two years of the chemical brush control program. Respraying will be done when the brush has reseeded or resprouted sufficiently to justify respraying. The company found by experience that the best results were obtained on brush that had been cut a month or six weeks prior to spraying.

The Oconee Electric Membership Corporation, Dudley, Georgia, the New Hampshire Electric Cooperative, Inc., Plymouth, New Hampshire, the Bayfield Electric Cooperative, Inc., Iron River Wisconsin, and the Sequachee Valley Electric Cooperative, South Pittsburgh, Tennessee, have indicated no plans to continue chemical brush spraying in 1949.

# VII. RECOMMENDATIONS FOR BRUSH CONTROL PROGRAMS

## A. INITIAL FOLIAGE SPRAY PROGRAMS

It is generally recommended by manufacturers and experimenters that chemicals be tested in a local area before large scale applications are made. Present indications are that the growth regulators and "Ammate" are the most promising herbicides, due to their lower cost, non-toxic effect on farm animals and the degrees of kill of woody plants. REA-financed power systems planning to use foliage sprays for the first time should consider whether they want to do the work with their own crews, or hire a contractor with his crew and equipment to do the work. This can be done by comparing the advantages and disadvantages of both methods in the locality involved. The chemicals required should be ordered well in advance of the spraying season. A partial list of companies selling herbicides is contained in Appendix II on page 19 .

A survey should be made of sample portions of the right-of-way to be sprayed to determine the major species of plants present on the typical right-of-way. By referring to Tables V and VI, a determination can be made of the probable percentage of woody plant control possible with the use of growth regulating herbicides. It is suggested that local agricultural authorities be consulted, if necessary, for information on the species present. If the survey indicates that the majority of the species present are tolerant or erratic in their reactions to the growth regulators, it may be desired to use "Ammate" instead.

Many factors will affect the results of the application of chemical sprays. They include percentages of the various species making up the plant population, size of plants, equipment used, concentration of spray applied, coverage obtained, stage of growth of the various species, and atmospheric conditions (particularly when the growth regulators are used). When foliage sprays are used, the best results can be expected when the plants are in the succulent growth stage, when the temperature is 50 degrees F. or higher and when the plants are not over 6 ft. tall. Leaves should be thoroughly sprayed.

It is suggested that each test cover an area of approximately 10 acres, easily accessible for observation. Control (or untreated) areas should be left nearby so that a check on the effects of the spraying can be made. Records should be made of the common names of the principal species of brush on each plot.

1. The following spraying procedures are suggested:

   (a) 2,4-D and 2,4,5-T

   When a study of the species present indicates that 2,4-D will control most of the brush, the mixture should consist of three quarts of 2,4-D 44% ester (2.5 lb. acid equivalent) per 100 gallons of water. For most combinations of species, however, it is believed that better control can be effected by the use of a combination of one and a half quarts (1.25 lb. acid equivalent) each of the 44% ester forms of 2,4-D and 2,4,5-T per hundred gallons of water. These concentrations are equivalent to 3 parts of acid to 1000 parts of water or 3000 ppm (parts per million), and are used as high volume sprays at the rate of 100 to 200 gallons of solution per acre. The same concentration of a solution of any other 2,4-D or 2,4,5-T compound containing a different percentage of ester may be calculated by multiplying the quantity of chemical given above by the ratio of 44% to the percent ester content of the chemical used.

   Care should be taken not to get the spray near farm crops or other beneficial plants, subject to damage by the growth regulators. After the equipment has been used to apply the herbicides and before it is used for other spray work, it should be thoroughly cleaned. Household ammonia added to the rinse water will help clean the equipment.

   The equipment should be rinsed several times. A quantity of the rinse solution should be sprayed through the hose and nozzle. Growth regulators will contaminate wood tanks which must not be used again for crop spraying. It is recommended, where possible, that any equipment used to apply growth regulators be not used for handling any other agricultural chemicals.

   (b) "Ammate"

   If tests with Ammate are desired, a spray solution consisting of one pound of chemical per gallon of water should be applied. The spray should not be allowed to fall on farm crops or other valuable plants. It kills grass as well as broad-leafed plants. Ammate should be kept in tightly covered containers. The spray or dry crystals are corrosive to metal. Spraying equipment should be thoroughly rinsed immediately after using the chemical.

2. The test plots should be checked one month after spraying to determine the percentage of foliage killed for each of the major species

   Spots missed by the original spraying or species not damaged when growth regulators were used should be resprayed. Compression or knapsack type sprayers may be best suited for this touch-up work. The plots should be checked during the following growing season to determine the percentage of permanent kill on each of the major species.

3. Power spraying equipment that will supply up to 200 pounds per square inch will be satisfactory for the original spraying. (The Louisiana law specifies a maximum pressure of 50 psi when approved forms of 2,4-D are used).

   Such equipment may be rented from a local contract spraying service company. If this is done, the company should be advised of the necessity of thoroughly cleaning the sprayer after using the weed killing chemicals. An additional truck with old oil drums or tanks for hauling water and mixing the chemical solution will prove useful. Successful brush spraying can be done with a knapsack sprayer, although some users have found this method too slow. A satisfactory lightweight outfit for low volume applications consists of a 5-gallon knapsack sprayer, fitted with a boom 8 1/2 feet long, of 1/4-inch aluminum tubing and fitted with a hand grip, balance sling, shut-off valve and four "Monarch" nozzles, No. 59 or A90, or equivalent, spaced 16 inches apart. About 20 gallons of spray mixture will be required per acre for low volume spraying. Therefore the strength of the mixture should be approximately five times the strength of the mixture used for high volume spraying.

   If the tests result in at least 80 percent control or more of the woody plants, the use of the chemicals tested may be considered practicable. If results are favorable, the user may desire to purchase power spraying equipment. A small outfit, such as that used by the South Crawford Rural Electric Cooperative or the Winnebago Rural Electric Cooperative Association will not require a large outlay of capital and, with a two-man crew, will spray about two miles per day. The latter cooperative, however, is now of the opinion that a unit with higher pressure would be more desirable. A larger outfit, similar to that used by the Whitley County Rural Electric Membership Corporation or the Northern Neck Electric Cooperative, will require three men to operate and will spray 10 to 15 miles per day. A partial list of the companies manufacturing sprayers and accessories is given in Appendix III, page 20 .



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## B. CONTINUED EXPERIMENTS

### 1. Foliage Sprays

Some of the REA-financed power systems that experimented with herbicides the first year, plan not to spray on a large scale the following year, but to make further tests. For this group the following foliage spray tests are suggested:

(a) If only one application of a herbicide has been made to a test plot and partial success has been attained, the effectiveness of respraying should be investigated.

(b) If the chemical solutions described on page 7 have not been tried, tests should be made with them.

(c) Different concentrations of solutions of "Ammate", 2,4-D and 2,4,5-T should be tested for relative effectiveness.

(d) Test data on the effectiveness of "Atlacide", pentachlorophenol and new herbicides are desirable. Recommendations of the manufacturers for preparing and applying the solutions of these chemicals should be followed.

### 2. Stump Treatments

Tests of stump sprays (one form of cut surface treatment) are also recommended, particularly in areas being cleared for new construction. This type of treatment is also expected to prove useful where cutting of brush and trees is a part of the regular maintenance program. Stump treatment will prevent much of the resprouting that otherwise would occur. As this can be done at any time of the year, it is possible to use the growth regulator chemicals during the dormant season with the greatest safety.

(a) 2,4-D and 2,4,5-T

Of the growth regulators the recommended solution is one pint each of 2, 4-D and 2,4,5-T 44% esters to five gallons of kerosene or No. 2 fuel oil. This solution may be applied with a 5-gallon compression or knapsack sprayer, equipped with oil resistant check valves, pump leathers and hose, and having a single nozzle.

Sufficient quantities of the spray should be applied to thoroughly wet the entire freshly cut surface and the sides of the stump. The effectiveness of wetting only the outer two-inch edge of the cut surface and the sides of larger stumps should also be tested.

An alternative mixture consists of two pints of 2,4-D 44% ester to five gallons of kerosene or No. 2 fuel oil. Different experimenters recommend strengths of these herbicides varying from two to 14 parts of 2,4-D or 2,4,5-T 44% ester to 100 parts of the oil.

(b) "Ammate"

"Ammate" may be applied to freshly cut surfaces of stumps, either in solution or as a dry salt. Spray solutions ranging in strength from four to 10 lb. per gal. of water are suggested. In order to dissolve the "Ammate" in the stronger solutions, it is necessary to let the chemical remain in water for several hours. The amount of dry "Ammate" to use varies from a layer one-quarter inch thick on a small stump to one inch on a larger stump.

### 3. Treatments in Pole and Substation Yards and Around Wood Pole Structures

Where it is desired to control weeds, principally herbaceous types, in substation and pole yards and around wood pole structures tests of the following herbicides are suggested:

(a) Borax or "Borascu", applied on the soil at the rate of 15 lb. per 100 sq. ft. for heavier growth and 10 lb. per 100 sq. ft., where the growth has been "scalped" or cut off at the surface of the ground.

(b) "Atlacide," applied as recommended by the manufacturer for the existing growth.

(c) "Penta General Weed Killer Concentrate", applied as recommended by the manufacturer. This herbicide contains a small amount of 2,4-D.

(d) Sodium or ammonium trichloroacetate, alone and in combination with 2,4-D, applied as recommended by the manufacturer.

## C. LARGE SCALE OPERATIONS

Many successful users of chemicals for brush control will, no doubt, continue with this phase of right-of-way maintenance. They should consider the following activities:

1. Making limited experiments with chemicals, equipment and methods not used in present work, to extend chemical brush control to localities or species not now covered.

2. Leading discussions with, and presenting papers describing their methods to managers of other power systems having similar brush control problems.

3. Keeping records of brush spraying to indicate limitations and advantages of this method of brush control.

4. Planting grasses, and possibly desirable low-growing shrubs, on some of the areas from which undesirable brush has been eradicated. Local agricultural authorities should be consulted for information about suitable species. Such planting would prevent erosion of the soil and reseeding of undesirable plants.

5. Developing more economical applications of the procedures now being followed.

### D. DATA ON FUTURE BRUSH CONTROL WORK

The Rural Electrification Administration will greatly appreciate receiving any data on future brush control work done by power systems, particularly the following:

1. Types of treatment.
2. Types and costs of chemicals used.
3. Kind of equipment used, including rental or purchase costs.
4. Acreage treated.
5. Amount of chemical per acre and, in the case of spraying, strength and quantity of solution per acre.
6. Names of species treated, density and height of growth, stage of growth, and effect of treatment on each.
7. Dates of application and weather conditions, such as temperature, humididty, whether sunny or cloudy and whether wind was blowing.
8. Comparison of total per-acre cost of chemical control with that of other methods used for controlling similar right-of-way brush.

## VIII. CONCLUSIONS

The results obtained and the future plans of most of the rural power system operators who have done brush control work with chemicals indicate the following:

1. The proper use of herbicides results in sufficient control to justify their continued use. Experience has shown that brush often can be controlled by chemical spraying at less cost than by cutting.

2. Application techniques and stage of growth of plants to which the chemicals are applied are important in relation to the effectiveness of the chemicals.

3. Precautions must be observed in the use of the growth regulators where adjacent crops or ornamental plants are likely to be injured by spray drift or volatilization.

Although much testing has already been done on the chemical control of brush, the need of future testing for several years is apparent. More experiments will indicate the effectiveness of herbicides which have not yet been tested on many woody plants. New herbicides and the better use of existing herbicides will be developed. Research on spray nozzles and the general improvement of spray equipment for applying herbicides to brush are expected to result in more efficient application of sprays.

Reporting the results of any tests of chemical brush control methods, made this year, will be very valuable in developing more effective and economical methods of brush control. Information on chemical treatments, cutting and burning will be useful.

TABLE I

# CHEMICAL SOLUTIONS USED FOR FOLIAGE SPRAYING

| CHEMICAL: 2,4-D (40 OR 44% ESTER) WITH WATER: UNLESS OTHERWISE NOTED | | | |
|---|---|---|---|
| Used by | Pints of concentrate per hundred gallons of water | Gallons of solution applied per acre | Results |
| Whitley County Rural Electric Membership Corp., Columbia City, Ind. | 6 | 200 | Estimated 75% kill of all species except oaks and hickory. |
| South Crawford Rural Electric Cooperative Denison, Iowa | 2 | 55 | Not conclusive,† all species appeared damaged, except wild cherry. |
| Winnebago Rural Electric Cooperative Association Thompson, Iowa | 40<br>8 | 25<br>150 | Estimated percentage killed: Willow 80 to 90; box elder, 70; cottonwood 50; ash, 20; oaks, 5; soft maple, none. |
| Sugar Valley Electric Cooperative Mound City, Kans. | 3 | 200 | Good results on elm, walnut, box elder, sumac, wild grape; little damage to oaks, none to osage orange. |
| Magnolia Electric Power Association McComb, Miss. | 5 | --- | Estimated 60 to 75% kill. Wild blackberry, wild grape, and smilax not affected. Slight effect on sweet gum, poplar, hickory, oak, ash, sumac. |
| Platte-Clay Electric Cooperative, Inc. Platte City, Mo. | 2 3/4 to 11 (56%)<br>12 | 200<br>200 | The 56% ester was used in 1947. Results varied. Both year's treatments damaged elm, poison ivy, blackberry and box elder but not osage orange, honey locust and maple. Respraying killed the locust. |
| New Hampshire Electric Cooperative Plymouth, N. H. | ---<br>14% | --- | Not conclusive.† Estimated kill is 10%. Major species were maple, beech, oak, birch, poplar, cherry, alder, elm, willow and briars. |
| Sequachee Valley Electric Cooperative South Pittsburgh, Tenn. | 6 | 22 | 50% of brush killed. Oak, maple, pine and sour wood appeared to be killed only at tips of branches. |
| Northern Neck Electric Cooperative Warsaw, Va. | 4<br>6 (20%) | 200<br>200 | The 44% ester concentrate in water killed 50% of the brush. Oak, maple, sweet gum and hickory were not greatly affected. The 20% ester used experimentally gave slightly poorer results. |
| Bayfield Electric Cooperative, Inc. Iron River, Wis. | 6<br>8<br>12 | 1000<br>1000<br>1000 | Not conclusive.† Oaks and maples not greatly damaged. |
| Bell Telephone Laboratories Murray Hill, N. J. | 4 | 175 | Not conclusive.† |
| West Penn Power, Co. Pittsburgh, Pa. | 6 | 125 | Some ash, oaks and maple sprayed in 1947, resprouted in 1948. |

TABLE I (Continued)

| CHEMICAL: 2,4,5-T WITH WATER | | | |
|---|---|---|---|
| Used by | Pints of concentrate per hundred gallons of water | Gallons of solution applied per acre | Results |
| Sugar Valley Electric Cooperative Association | 4 | 200 | Not conclusive.† |
| Platte-Clay Electric Cooperative, Inc. | varied | --- | Not conclusive.† |
| Bell Telephone Laboratories | 4 | 218 | Not conclusive.† |
| CHEMICAL: 2,4-D (40 OR 44% ESTER) AND 2,4,5-T ESTER WITH WATER | | | |
| Oconee Electric Membership Corp. Dudley, Ga. | 3 each | 150 | Estimated 80 to 90% brush killed. Oaks, poplar, persimmon and gall berry showed the most resistance |
| Whitley County Rural Electric Membership Corp. | 3 each | 200 | Not conclusive † Apparently killed 75% of all species except oaks and hickory. |
| Platte-Clay Electric Cooperative, Inc. | varying | --- | Not conclusive.† |
| Central Electric Cooperative, Inc Parker's Landing, Pa. | 6 each | 150 | Not conclusive.† Oaks and wild apples slightly damaged, no apparent damage to maples. |
| Northern Neck Electric Cooperative | 2 each | 200 | Killed estimated 80% of brush. |
| West Penn Power Company | 3 each | 100 to 125 | Controlled all species on right-of-way, except basswood, ash and beech. |
| CHEMICAL: "AMMATE" WITH WATER | | | |
| Used by | Rate of Application | | Results |
| Platte-Clay Electric Cooperative | Varying | | Not conclusive.† |
| Hancock-Wood Electric Cooperative, Inc. North Baltimore, Ohio | 700 lb. to 1.2 acre, average height, 18 ft. | | Not conclusive.† |
| Sequachee Valley Electric Cooperative | One lb. per gal. 70 to 81 gal. solution per acre. | | Killed estimated 50 to 90% of all brush. Oak, hickory and pine not greatly damaged. |
| Bayfield Electric Cooperative, Inc. | Three solutions: 78 lb.) 117 lb.) per 38 gal. 146 lb.) | | Not conclusive.† |
| Northern Neck Electric Cooperative | 3/4 lb. per gal. 200 gal. per acre. | | Killed estimated 80% of brush |
| Bell Telephone Laboratories | 1-1/2 lb. per gal. | | Fair, not conclusive.† |

† Effects of chemical were considered to be incomplete, as spraying had been done a comparatively short time before this observation.

TABLE II

# POWER SPRAY EQUIPMENT USED

| Used by | Manufacturer | Description | Approx. Cost |
|---|---|---|---|
| Whitley County Rural Electric Membership Corporation Columbia City, Ind. | A. B Farquahar Company 21 Duke St. York, Pa. | Potato sprayer, driven by 22-hp. gasoline engine, with 6-nozzle hand boom and separate gun for high or dense growth. With 400-gal. tank for truck mounting. | $1500 |
| South Crawford Rural Electric Cooperative Denison, Iowa | ---------- | Centrifugal pump, driven by 1 1/2-hp. Briggs and Stratton gasoline engine, with 50-ft hose and T-shaped hand boom with three No. 22 nozzles spaced one ft. apart. | 200 |
| Winnebago Rural Electric Cooperative Association Thompson, Iowa | Essick Manufacturing Company 1950 Santa Fe Ave. Los Angeles, Calif. | "Air-power," Model 700R-T air compressor driven by 1 1/2-hp. gasoline engine, mounted on top of 140-gal. tank, 50 to 60 psi, with 50-ft. hose and hand boom with 5 fog nozzles, later replaced with orchard gun. | 400 |
| Sugar Valley Electric Cooperative Association, Inc. Mound City, Kans. | ---------- | Power take-off weed sprayer, for tractor mounting, with hand boom with three nozzles, 65-psi. Two 55-gal. drums hauled on trailer. | --- |
| Platte-Clay Electric Cooperative, Inc. Platte City, Mo. | John Bean Manufacturing Company 61 Hazel St. Lansing, Mich. | Pump, 35-gpm, 200 to 600-psi, driven by 1939 model Ford V-8 engine. With 1000-gal. tank and ejector type filler, mounted on 2 1/2-ton truck. | --- |
| Northern Neck Electric Cooperative Warsaw, Va. | John Bean Manufacturing Company | Pump, Model 4814MT, 15-gpm, driven by gasoline engine, with 400-ft. hose, two No. 780 "Spraymaster" guns and a siphon injector. | 1465 |
| Davey Tree Expert Company Kent, Ohio | John Bean Manufacturing Company | Pump, orchard type, 600-psi , 15-gpm driven by 10 to 15-hp. gasoline engine. With 250-gal. tank, two hoses and nozzles, one nozzle with 1000 ft. of hose. | --- |
| West Penn Power Company Pittsburgh, Pa. | John Bean Manufacturing Company | Spray rig, model 15, orchard type, 250-psi. (maximum), with 250-gal. tank, pecan nozzle, 400-ft. hose. Mounted on Dodge "Power Wagon" truck. | $4400 |
| Weed Control Service Portland, Ore. | Hardie Mfg. Co. Hudson, Mich. John Bean Mfg. Co. | Six 4 x 4 trucks, with 500-psi, 10-20 gpm, gasoline engine driven pump; engine, 500-gal. tank and 500 ft. hose mounted on each truck.<br>Two crawler tractors, with spray equipment mounted on trailer, each pump 500 psi, 20 gpm, with 500 ft. hose.<br>Auxiliary equipment: One "Jeep" and one truck with 1800 gal. tank, hose, and 2-1/2-inch gear transmission for pump. | $36000 |

TABLE III

# COST DATA

| Source of Data | Chemical Used | Area Sprayed | Cost of spraying per acre | | | Remarks |
|---|---|---|---|---|---|---|
| | | | Labor | Chemical | Total | |
| Oconee Electric Membership Corp. Dudley, Ga. | Equal parts 2,4-D and 2,4,5-T | 10 acres | --- | --- | $30.00 | Contract work by Vegetation Control Service, Atlanta, Ga. |
| Whitley County Rural Electric Membership, Corp. Columbia City, Ind. | 2,4-D | 150 miles 8 to 10 ft. wide | $2.50 | $10.50 | 13.00 | Labor costs shared with county. Both herbaceous and woody growth sprayed. |
| South Crawford Rural Electric Cooperative Denison, Iowa | 2,4-D | 5 to 8 ft. wide | --- | --- | 55.00 | $55.00 per mile of brush sprayed. |
| Platte-Clay Electric Cooperative, Inc. Platte City, Mo. | 2,4-D | 110 miles 15 ft. wide | --- | --- | 30.00 | Estimated cost. |
| New Hampshire Electric Cooperative, Inc. Plymouth, N. H. | 2,4-D | 300 acres | --- | --- | 30.00 | Contract work by Tree Preservation Co., Elmsford, N. Y. |
| Hancock-Wood Electric Cooperative, Inc. North Baltimore, Ohio | "Ammate" | Test plot 15 ft. by 3700 ft. | $15.42 | 83.50 | 98.92 | Contract work by Davey Tree Expert Co., Kent, Ohio. Equipment rental, additional $20.83. |
| Central Electric Cooperative, Inc. Parker's Landing, Pa. | Equal parts 2,4-D and 2,4,5-T | 10 acres | --- | --- | 30.00 | Contract work by Vegetation Control Service. |
| Sequachee Valley Electric Cooperative South Pittsburgh, Tenn. | 2,4-D | 10 acres 20 or 30 ft. wide | 14.00 | 8.00 | 22.00 | Additional cost of $4.00 per acre for rental of sprayer. |
| | "Ammate" | 10 acres | 14.00 | 14.00 | 28.00 | |
| Northern Neck Electric Cooperative Warsaw, Va. | Equal parts 2,4-D and 2,4,5-T | 20 acres | --- | --- | Average $26.25 | Cost includes overhead and transportation, as well as cost of spraying 68 acres with 2,4-D and respraying with mixture of 2,4-D and 2,4,5-T. |
| | "Ammate" | 7 acres | --- | --- | | |
| | 2,4-D | 20 acres | --- | --- | | |
| | 2,4-D in oil | 20 acres | --- | --- | 45.00 | Contract work by Asplundh Tree Expert Co., Jenkintown, Pa. |
| West Penn Power Company Pittsburgh, Pa. | Equal parts 2,4-D and 2,4,5-T | 4800 acres | --- | --- | $25.00 Average | Includes cost of insurance to cover any damage to crops by spraying contractor |

TABLE IV

# REACTIONS OF WOODY PLANTS TO 2,4-D SOLUTIONS†

## PLANTS KILLED BY ONE APPLICATION

| | | | |
|---|---|---|---|
| Barberry, European* | Hackberry (Celtis | Pine, loblolly | Wormwood, purple stem |
| Birch, river | mississippiensis) | Prickly ash | Willow, narrow leaf |
| Gum, tupelo | Hazel (Corylus cornuta) | Sumac, staghorn | |

## PLANTS KILLED BY REPEATED APPLICATIONS

| | | |
|---|---|---|
| Buckbrush (Symphoricarpos occidentalis) | Licorice | Oak, poison |
| | Moonseed | Tea, New Jersey |

## PLANTS KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH

| | | | |
|---|---|---|---|
| Barberry, Native | Elderberry | Hickory | Sumac, smooth |
| Colorado | Elder, box | Plum, wild | Sycamore |
| Cherry, wild | Elm, Japanese | Sassafras | Tree of Heaven |
| Currant, Sierra Nevada, | Gum, sweet | Silverberry | Trumpet vine |
| Squaw, stink, western | Hazel nut (Corylus | Skunkbush | Tulip tree |
| black | americana) | Spicebush | Virginia creeper |

## PLANTS SOMETIMES KILLED BY REPEATED APPLICATIONS BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH

| | | | |
|---|---|---|---|
| Birch (Betula | Elm, red | Oaks, black jack, | Plum, sand |
| papyrifera) | Hawthorn | bur, dwarf chinq., | Sagebrush, sand§ |
| Cherry, choke | **Mesquite | post | Soapweed |
| Cottonwood | Mulberry (Morus | Pear, prickly | Walnut, black |
| Dogwood, gray | alba) | Persimmon | Willow, ditchbank |

## PLANTS SOMETIMES KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS; BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH

| | | | |
|---|---|---|---|
| Alder | Dogwood, flowering | Juneberry | Walnut, white |
| Apple, American crab | Elm, American | Locust, black | Willow, black |
| Buckbrush (Symphoricarpos orbiculatus) | Gooseberry | and honey | |
| | Grape, wild | Poplar, black | |
| Currants, red flower | Hackberry | and white | |
| and sticky | Ivy, poison | Snowberry | |

## PLANTS NOT KILLED BY REPEATED APPLICATIONS

| | | | |
|---|---|---|---|
| Apple, common | Currants, Alpine, black | Maple | Mahonia |
| Ash | prickly and wild | Mulberry, red | Spruce |
| Basswood | Cypress, bald | Oaks, laurel, red | Waahoo (burning |
| Bittersweet | Dewberry | scrub, shin, white | bush) |
| Blackberry | Dogwood (Cornus | Osage orange | Willow, glaucous |
| Briar, common | stolonifers) | Papaw | and broad leaf |
| green | Elm, winged | Pine, western yellow | |
| Buttonball | Juniper | Raspberry | |
| Cedar, red | Lead plant | Roses, wild and | |
| Cinquefoil, shrubby | Lilac, common | prairie | |

† Source of information: North Central Weed Control Conference Report, 1948. Data based on two years of test work.

* Cut surface treatment, not by foliage sprays.

§ One lb. of acid, amine or salt or slightly less than one lb. of ester per acre applied by airplane.

** Killed by repeated applications of 10,000 and 25,000 ppm in diesel oil or by 5000 ppm in water when plant was in succulent growth in early season or mid-season, also by 10,000 and 25,000 ppm in water in early or mid-season stages of growth

TABLE V

# REACTIONS OF WOODY PLANTS TO 2,4,5-T SOLUTIONS†

| PLANTS KILLED BY ONE APPLICATION | | |
|---|---|---|
| Cherry, pin | Honeysuckle | Sumac, smooth |
| Currant, Alpine | Juneberry | Sumac, staghorn |
| Dewberry | Locust, honey | Sycamore |
| Grape, wild | Maple, soft | Trumpet vine |
| Hazelnut (Corylus Americana) | Plum, sand | Tung |
| | Poplar, white | Willow, bright |

| PLANTS KILLED BY REPEATED APPLICATIONS | | |
|---|---|---|
| Birch | Hickory | Persimmon |
| Cherry, choke | Oaks, black jack, bur, dwarf chinq., post | Waahoo (Burning bush) |
| Elm, winged | | |

| PLANTS KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH | | |
|---|---|---|
| Blackberry | Elm, American | Oak, white |
| Cherry, wild | Gooseberry | Sassafras |
| Currants, prickly, squaw, sticky, stink | Locust, black | Skunk brush |
| | | Willow, black |

| PLANTS SOMETIMES KILLED BY REPEATED APPLICATIONS BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH | | |
|---|---|---|
| Elm, Chinese | Hackberry | Hazelnut, beaked |
| Fir, balsam | Hawthorn | *Mesquite |

| PLANTS SOMETIMES KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH | |
|---|---|
| Alder, speckled | Ivy, Poison |
| Buckbrush | Osage orange |

| PLANTS NOT KILLED BY REPEATED APPLICATIONS | | |
|---|---|---|
| Ash, white | Papaw | Rose, prairie |
| Cedar, red | Pines, jack, red and white | Sagebrush, sand |
| Maples, red and sugar | Raspberry | Spruce, white |
| Oaks, red and shin | | Tamarack |

†Source of information; North Central Weed Control Conference Report, 1948. Data based on one year of test work.

*Killed while in succulent growth by various tests with repeated applications of solutions of diesel oil and of water.

TABLE VI

# REACTIONS OF WOODY PLANTS TO COMBINATION OF 50% EACH OF 2,4-D AND 2,4,5-T APPLIED AS FOLIAGE SPRAYS; 3000 PPM CONCENTRATION†

| PLANTS KILLED BY ONE APPLICATION | | |
|---|---|---|
| Blackberry, wild | Grape, wild | Sassafras |
| Cherries, choke, fire and wild black | Maple, ash-leaved | Spice bush |
| | Raspberry, black | Sumac, staghorn |
| **PLANTS KILLED BY REPEATED APPLICATIONS** | | |
| Birch, white | Dogbane | Honeysuckle, Japanese |
| Chestnut | Elder, common | Virginia creeper |
| **PLANTS KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH** | | |
| Apple, American crab | Locust, common | Tulip tree |
| Aspen, trembling | Oaks, red, white | Walnuts, black, white |
| Elm, American | Osage orange | |
| Hickory, shellbark | Sycamore | Willow, black |
| Ivy, poison | Tree of Heaven | |
| **PLANTS SOMETIMES KILLED BY REPEATED APPLICATIONS BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH** | | |
| Briar, common green | Maples, red, striped, sugar | Pine (Pinus alba) |
| Dewberry | | Pine, red |
| Hawthorn | Oak, laurel | |
| **PLANTS SOMETIMES KILLED BY ONE APPLICATION OR BY REPEATED APPLICATIONS BUT NOT ALWAYS KILLED BY REPEATED APPLICATIONS AT CERTAIN STAGES OF GROWTH** | | |
| Dogwood, flowering | Poplar, Carolina | |
| **PLANTS NOT KILLED BY REPEATED APPLICATIONS** | | |
| Apple, common | Beech, American | Hercules club |
| Ash, white | Bittersweet, climbing | Laurel |
| Basswood | Cedar, red | |

†Source of information: North Central Weed Control Conference Report, 1948. Data based on one year's results.

TABLE VII

# EFFECTS OF GROWTH REGULATORS ON WOODY PLANTS IN VARIOUS STAGES OF GROWTH†

| Stage of Growth | Single chemical | | | | | | Combination of 50% each of 2,4-D and 2,4,5-T 3000 parts per million | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2,4-D | | | 2,4,5-T | | | | | |
| | Tests made | Percent killed by one Application | Percent killed by Repeated Applications | Tests made | Percent killed by one Application | Percent killed by Repeated Applications | Tests made | Percent killed by one Application | Percent killed by Repeated Applications |
| Young seedlings | 132 | 50 | 24 | 60 | 49 | 18 | 50 | 54 | 30 |
| Early season, succulent growth | 202 | 24 | 36 | 67 | 34 | 52 | 50 | 38 | 42 |
| Midseason, succulent growth | 224 | 20 | 38 | 89 | 36 | 48 | 50 | 38 | 38 |
| Midseason, no succulent growth | 170 | 20 | 35 | 79 | 25 | 32 | 48 | 31 | 40 |
| Late season | 108 | 12 | 23 | 56 | 27 | 32 | 46 | 22 | 37 |
| Dormancy | 24 | 20 | 17 | 17 | 0 | 0 | ** | ** | ** |

**No tests during dormancy were reported.

†Data are a statistical summary of two year's test results with 2,4-D and one year's test results with 2,4,5-T and with combination of 2,4-D and 2,4,5-T, as listed in North Central Weed Control Conference Report, 1948.

APPENDIX I

# LIST OF COLLABORATORS

Oconee Electric
Membership Corp.
Dudley, Ga.

Whitley County Rural
Electric Membership Corp.
Columbia City, Ind.

South Crawford Rural
Electric Cooperative
Denison, Iowa

Winnebago Rural Electric
Cooperative Association
Thompson, Iowa

Sugar Valley Electric
Cooperative Association,
Inc., Mound City, Kans.

Magnolia Electric
Power Association
McComb, Miss.

Platte-Clay Electric
Cooperative, Inc.
Platte City, Mo.

New Hampshire Electric
Cooperative, Inc.
Plymouth, N. H.

Hancock-Wood Electric
Cooperative, Inc.
North Baltimore, Ohio

Central Electric
Cooperative, Inc.
Parker's Landing, Pa.

Sequachee Valley
Electric Cooperative
South Pittsburg, Tenn.

Craig-Botetourt
Electric Cooperative
New Castle, Va.

Northern Neck
Electric Cooperative
Warsaw, Va.

Bayfield Electric
Cooperative, Inc.
Iron River, Wis.

Southern California
Edison Co., Limited
Edison Building
Los Angeles 53, Calif.

West Penn Power Co.
P. O. Box 1736
Pittsburgh 30, Pa.

Ohio Public Service Co.
Alliance, Ohio

L. R. Snoke
Bell Telephone
Laboratories, Inc.
Room 1D-213
Murray Hill, N. J.

K. M. Ashbaugh, Manager
Vegetation Control Service
P. O. Box 146, Sta. A
Atlanta, Ga.

Davey Tree Expert Co.
Kent, Ohio

Asplundh Tree Expert Co.
505 York Road
Jenkintown, Pa.

James L. Claflin, Manager
Weed Control Service, Inc.
1924 S. E. Sixth Ave.
Portland 14, Oregon

L. W. Melander, Chairman
Subcommittee on Research
concerning the Eradication
of Woody Plants, North
Central Weed Control Con-
ference
111 General Office Building
Minneapolis 1, Minn.

L. W. Kephart, L. S. Evans
and John W. Mitchell
U. S. Department of Agri-
culture
Agricultural Research Admin-
istration, Bureau of Plant
Industry, Soils and Agri-
cultural Engineering
Beltsville, Md.

Dow Chemical Co.
Midland, Mich.

Pacific Coast Borax Co.
51 Madison Ave.
New York 10, N. Y.

E. I. duPont de Nemours and
Co.
Grasselli Chemicals Dept.
Wilmington 98, Del.

Chapman Chemical Co.
Liberty Life Bldg.
Charlotte 2, N. C.

Reasor-Hill Corp.
705 McGee St.
Kansas City, Mo.

Chipman Chemical Co.
44 Factory Lane
Bound Brook, N. J.

Monsanto Chemical Co.
1700 South 2nd St.
St. Louis 4, Mo.

APPENDIX II

# PARTIAL LIST OF VENDORS OF HERBICIDES*

## FORMS OF 2,4-D OR 2,4,5-T

Aero Chemical Co., Inc.
Box 214, Kansas City, Mo.

Aggie Chemical &
Engineering Co.
Box 176, Tulsa 1, Okla.

Agricultural Chemical
Div.,Andrew-Netzel
120 E. Hickory St.
Kankakee, Ill.

Agricultural Supply Co.
Spring Green, Wis.

American Chemical Paint Co.
Ambler, Pa.

Associated Chemists, Inc.
North Collins, N. Y.

Associated Chemicals
505 Sunderland Bldg.
Omaha 2, Nebr.

Baird & McGuire, Inc.
St. Louis, Mo.

Barada & Page
Chemical Co.
Kansas City, Mo.

California Spray
Chemical Corp.
Richmond, Calif.

Consumers Cooperative
Kansas City, Mo.

Dodson Chemical Co.
1022 W. 5th St.
Amarillo, Texas

Douglas Chemical & Supply Co.
1324-26 W. 12th St.
Kansas City 7, Mo.

E. I. duPont
de Nemours & Co.
Grasselli Chemicals Dept.
Wilmington 98, Del.

Evans Orchard Supply Co.
Kansas City, Mo.

Industrial Chemical Div.
J. T. Baker Chemical Co.
Phillipsburg, N. J.

John Powell Chemical Co.
1 Park Ave.
New York 16, N. Y.

Lyon Chemical Co.
St. Paul, Minn.

Miller Chemical Co.
Omaha, Nebr.

Monsanto Chemical Co.
1700 S. 2nd St.
St. Louis 4, Mo.

Niagara Sprayer &
Chemical Div.
Food Machinery Corp.
Middleport, N. Y.

Oldbury-Electro Chemical Co.
New York, N. Y.

Pearson-Ferguson
Chemical Co.
Kansas City, Mo.

Pennsylvania Salt Mfg. Co.
1000 Widener Bldg.
Philadelphia 7, Pa.

Reasor-Hill Corp.
705 McGee St.
Kansas City, Mo.

R. J. Prentiss Co., Inc.
110 William St.
New York 7, N. Y.

Shannon Feed Co., Tulsa, Okla.

Sherwin-Williams Co.
101 Prospect Ave., N. W.
Cleveland 1, Ohio

Standard Agricultural
Chemicals, Inc.
13th & Jefferson Sts.
Hoboken, N. J.

Swift & Co., Chicago, Ill.

The Chipman Chemical Co.
Bound Brook, N. J.

The Dow Chemical Co.
Midland, Mich.

Thompson- Hayward
Chemical Co.
Kansas City 8, Mo.

Woodbury Chemical Co.
St. Louis, Mo.

## "AMMATE"

E. I. duPont De Nemours
and Co.
Grasselli Chemicals Dept.
Wilmington 98, Del.

## PENTACHLOROPHENOL

Monsanto Chemical Co.
1700 S. 2nd St.
St. Louis 4, Mo.

The Dow Chemical Co.
Midland, Mich.

## BORAX AND "BORASCU"

Pacific Coast Borax Co.
51 Madison Ave.
New York 10, N. Y.

## "PENTA GENERAL WEED KILLER CONCENTRATE"

Chapman Chemical Co.
707 Dermon Bldg.
Memphis 3, Tenn.

## "ATLACIDE"

Chipman Chemical Co.
44 Factory Lane
Bound Brook, N. J.

## "TRICHLOROACETIC ACID"

The Dow Chemical Co.
Midland, Mich.

*The above partial list is furnished for information, with the understanding that no discrimination is intended and no guarantee of reliability implied.

APPENDIX III

# PARTIAL LIST OF SPRAYING EQUIPMENT MANUFACTURERS*

## GENERAL SPRAYING EQUIPMENT

John Bean Mfg. Co.
61 Hazel St.
Lansing, Mich.

Essick Mfg. Co.
1950 Santa Fe Ave.
Los Angeles 21, Calif.

Evans Orchard Supply Co.
301-3-5 Delaware
Kansas City 6, Mo.

A. B. Farquahar
21 Duke St.
York, Pa.

Lowell Mfg. Co.
589 E. Illinois St.
Chicago 11, Ill.

New Ideal Sprayer Co.
Nashville, Ga.

J. A. Park Machinery Co.
Pueblo, Colo.

Jerome Simer Co.
422-428 Stinson Blvd.
Minneapolis 13, Minn.

Hardie Mfg. Co.
Hudson, Mich.

## NOZZLES AND ACCESSORIES

Accessories Mfg. Co., Inc.
705 McGee St.
Kansas City, Mo.

W. L. Hamilton & Co.
Bangor, Mich.

Monarch Mfg. Works, Inc.
2501 E. Ontario St.
Philadelphia 34, Pa.

Spray Engineering Co.
114 Central St.
Somerville, Mass.

Sprayer Supply Mfg. Co.
225 Front Ave. N. W.
Grand Rapids, Mich.

## KNAPSACK SPRAYERS

Blackwell Pear Burner Co.
5061 W. Commerce St.
San Antonio, Texas

The E. C. Brown Co.
900 Maple St.
Rochester 1, N. Y.

The Lofstrand Co.
2000 Horners Lane
Rockville, Md.

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